Aims

To investigate whether if SAB model can also be equally applicable in most of ICU patients (not just restricted on aortic aneurysm patients).

Methods

From MIMIC database, we included 31,645 patients for external validation of SAB model. The inclusion criteria didn't set special restriction on the type of disease at the aim of validating if the model can be equally applicable in most of ICU patients. Patients or the ICU admission were excluded meeting the following criteria: (I) for those who had multiple ICU admissions, we only remained the first admission record; (II) of whom ICU stay less than 24 hours; (III) who lacked of anion gap or bicarbonate record in the first day of ICU admission; (IV) who were younger than 18. The disease spectrum and baseline data of the selected external validation group are shown in *Tables S1,S2*.

Then, prediction result of each individual was calculated based on SAB model derived from the group of aortic aneurysm patients. Two widely used models (SAPSII and SOFA) and the SAB model were used to calculate the discrimination and calibration. Discrimination was measured by AUC while calibration was measured by Brier score and calibration curve, which are shown in *Table S3* and *Figure S1*.

Results

In external validation of SAB model in the large ICU cohort, the results had shown that the discrimination of the model didn't reach great level (AUC <0.75), and was lower than SAPSII and SOFA. *Figure S1* shows the calibration curve (dotted line) of SAB model in external validation group, which is below on the ideal line, meaning that the model may overestimated the mortality of patients in clinical use.
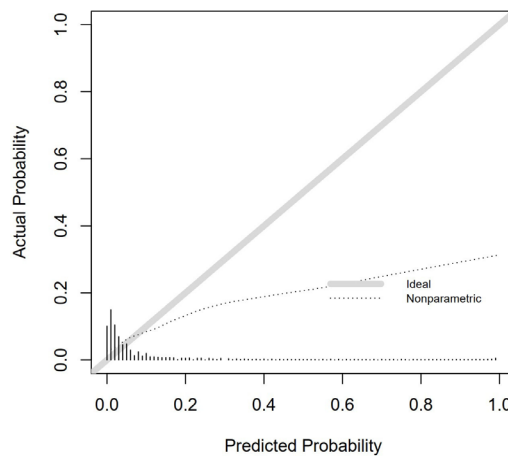
Figure S1 Calibration curve of SAB model in external validation group. Calibration curve shows the mean predicted probability of outcome against the observed proportion of clinical outcomes. SAB, Sepsis, Anion gap, Bicarbonate.

Table S1 Disease spectrum and prevalence of external validation group

Disease	Number (%)
Coronary atherosclerosis of native coronary artery	2,588 (8.2%)
Subendocardial infarction, initial episode of care	1,286 (4.1%)
Unspecified septicemia	1,142 (3.6%)
Aortic valve disorders	882 (2.8%)
Intracerebral hemorrhage	757 (2.4%)
Acute respiratory failure	685 (2.2%)
Subarachnoid hemorrhage	450 (1.4%)
Mitral valve disorders	407 (1.3%)
Acute myocardial infarction of other inferior wall, initial episode of care	380 (1.2%)
Acute myocardial infarction of other anterior wall, initial episode of care	379 (1.2%)
Pneumonia, organism unspecified	374 (1.2%)
Pneumonitis due to inhalation of food or vomitus	348 (1.1%)
Congestive heart failure, unspecified	342 (1.1%)
Acute kidney failure, unspecified	292 (0.9%)
Acute pancreatitis	268 (0.8%)
Cerebral embolism with cerebral infarction	258 (0.8%)
Cerebral artery occlusion, unspecified with cerebral infarction	246 (0.8%)
Hemorrhage of gastrointestinal tract, unspecified	224 (0.7%)
Other pulmonary embolism and infarction	224 (0.7%)
Subdural hemorrhage following injury without mention of open intracranial wound, with no loss of consciousness	206 (0.7%)
Septicemia due to Escherichia coli (E. coli)	204 (0.6%)
Secondary malignant neoplasm of brain and spinal cord	203 (0.6%)
Atrial fibrillation	201 (0.6%)
Diverticulosis of colon with hemorrhage	174 (0.5%)
Alcoholic cirrhosis of liver	155 (0.5%)
Paroxysmal ventricular tachycardia	146 (0.5%)
Other postoperative infection	144 (0.5%)
Hemorrhage complicating a procedure	139 (0.4%)
Subdural hemorrhage following injury without mention of open intracranial wound, unspecified state of consciousness	138 (0.4%)
Dissection of aorta, thoracic	136 (0.4%)
Subdural hemorrhage	134 (0.4%)
Malignant neoplasm of upper lobe, bronchus or lung	127 (0.4%)
Mitral valve insufficiency and aortic valve stenosis	127 (0.4%)
Methicillin susceptible Staphylococcus aureus septicemia	126 (0.4%)
Acute on chronic systolic heart failure	125 (0.4%)

Table S1 (*continued*)

Table S1 *(continued)*

Disease	Number (%)
Poisoning by aromatic analgesics, not elsewhere classified	125 (0.4%)
Acute and subacute necrosis of liver	124 (0.4%)
Acute and chronic respiratory failure	122 (0.4%)
Cirrhosis of liver without mention of alcohol	119 (0.4%)
Diabetes with ketoacidosis, type I (juvenile type), uncontrolled	119 (0.4%)
Streptococcal septicemia	118 (0.4%)
Chronic or unspecified duodenal ulcer with hemorrhage, without mention of obstruction	116 (0.4%)
Other septicemia due to gram-negative organisms	113 (0.4%)
Abdominal aneurysm without mention of rupture	112 (0.4%)
Cerebral aneurysm, non-ruptured	111 (0.4%)
Infection and inflammatory reaction due to other vascular device, implant, and graft	110 (0.3%)
Chronic or unspecified gastric ulcer with hemorrhage, without mention of obstruction	108 (0.3%)
Human immunodeficiency virus disease	108 (0.3%)
Obstructive chronic bronchitis with (acute) exacerbation	108 (0.3%)
Thoracic aneurysm without mention of rupture	106 (0.3%)
Acute myocardial infarction of unspecified site, initial episode of care	105 (0.3%)
Malignant neoplasm of other parts of bronchus or lung	105 (0.3%)
Occlusion and stenosis of carotid artery without mention of cerebral infarction	105 (0.3%)
Alcohol withdrawal	104 (0.3%)
Acute on chronic diastolic heart failure	98 (0.3%)
Cholangitis	97 (0.3%)
Other convulsions	95 (0.3%)
Acute myocardial infarction of inferoposterior wall, initial episode of care	94 (0.3%)
Acute vascular insufficiency of intestine	93 (0.3%)
Acute and subacute bacterial endocarditis	92 (0.3%)
Acute myocardial infarction of anterolateral wall, initial episode of care	91 (0.3%)
Blood in stool	88 (0.3%)
Malignant neoplasm of liver, primary	86 (0.3%)
Benign neoplasm of cerebral meninges	85 (0.3%)
Intestinal or peritoneal adhesions with obstruction (postoperative) (post infection)	85 (0.3%)
Ventricular fibrillation	77 (0.2%)
Closed fracture of base of skull with subarachnoid, subdural, and extradural hemorrhage, with loss of consciousness of unspecified duration	75 (0.2%)
Other diseases of trachea and bronchus	75 (0.2%)
Acute kidney failure with lesion of tubular necrosis	74 (0.2%)

Table S1 *(continued)*

Table S1 *(continued)*

Disease	Number (%)
Atherosclerosis of native arteries of the extremities with gangrene	72 (0.2%)
Acute myeloid leukemia, without mention of having achieved remission	71 (0.2%)
Closed fracture of intertrochanteric section of neck of femur	70 (0.2%)
Atrioventricular block, complete	69 (0.2%)
Diverticulitis of colon (without mention of hemorrhage)	69 (0.2%)
Other specified cardiac dysrhythmias	69 (0.2%)
Unspecified disease of pericardium	68 (0.2%)
Acute myocardial infarction of inferolateral wall, initial episode of care	66 (0.2%)
Malignant neoplasm of cardia	66 (0.2%)
Urinary tract infection, site not specified	64 (0.2%)
Rheumatic heart failure (congestive)	62 (0.2%)
Secondary malignant neoplasm of bone and bone marrow	62 (0.2%)
Grand mal status	61 (0.2%)
Accidental puncture or laceration during a procedure, not elsewhere classified	60 (0.2%)
Intestinal infection due to Clostridium difficile	60 (0.2%)
Secondary malignant neoplasm of lung	59 (0.2%)
Congenital insufficiency of aortic valve	58 (0.2%)
Subarachnoid hemorrhage following injury without mention of open intracranial wound, with no loss of consciousness	58 (0.2%)
Malignant neoplasm of lower lobe, bronchus or lung	56 (0.2%)
Hepatic encephalopathy	55 (0.2%)
Malignant neoplasm of kidney, except pelvis	55 (0.2%)
Other complications due to other vascular device, implant, and graft	55 (0.2%)
Other specified septicemias	55 (0.2%)
Malignant neoplasm of head of pancreas	54 (0.2%)
Ostium secundum type atrial septal defect	54 (0.2%)
Pneumococcal septicemia (streptococcus pneumoniae septicemia)	54 (0.2%)
Poisoning by benzodiazepine-based tranquilizers	54 (0.2%)
Diabetes with ketoacidosis, type II or unspecified type, uncontrolled	53 (0.2%)
Morbid obesity	52 (0.2%)
Subarachnoid hemorrhage following injury without mention of open intracranial wound, with loss of consciousness of unspecified duration	52 (0.2%)
Other	12,372 (39.1%)

Table S2 Baseline data of external validation group

Candidate variables	ICU-survival group (N=29,093)	ICU-death group (N=2,552)	P value
General condition			
LOS of hospital	7.73 (4.84, 13.00)	5.55 (2.44, 11.15)	<0.001***
LOS of ICU	2.42 (1.58, 4.46)	4.72 (2.29, 9.31)	<0.001***
In-hospital death	1,009 (3.5%)	2,531 (99.2%)	<0.001***
Admission type			<0.001***
Elective	4,804 (16.5%)	94 (3.7%)	
Emergency	23,499 (80.8%)	2,372 (92.9%)	
Urgent	790 (2.7%)	86 (3.4%)	
Age (years)	65.00 (52.00, 77.00)	72.00 (59.00, 81.00)	<0.001***
Male	16,579 (57.0%)	1,349 (52.9%)	<0.001***
Comorbidity			
Sepsis	1,853 (6.4%)	657 (25.7%)	<0.001***
Laboratory indicators			
Anion gap, maximum (mEq/L)	15.00 (12.00, 17.00)	18.00 (15.00, 21.00)	<0.001***
Anion gap, minimum (mEq/L)	12.00 (11.00, 14.00)	14.00 (12.00, 17.00)	<0.001***
Bicarbonate, maximum (mEq/L)	25.00 (23.00, 27.00)	24.00 (20.00, 27.00)	<0.001***
Bicarbonate, minimum (mEq/L)	23.00 (20.00, 25.00)	20.00 (16.00, 24.00)	<0.001***
Severity score			
GCS	15.00 (14.00, 15.00)	15.00 (13.00, 15.00)	<0.001***
SAPSII	33.00 (25.00, 41.00)	50.00 (39.00, 61.00)	<0.001***
SOFA	3.00 (2.00, 5.00)	7.00 (4.00, 10.00)	<0.001***

0.4% of patients had unknown value for GCS score; ICU, intensive care unit; LOS, length of stay; GCS, Glasgow Coma Scale; SAPSII, simplified acute physiology score II; SOFA, sequential organ failure assessment. ***, $P < 0.001$.

Table S3 Discrimination and calibration of models in external validation

Evaluation index	SAB model	SAPSII	SOFA
Discrimination, AUC (95% CI)	0.7223 (0.7113–0.7333)	0.7983 (0.7895–0.8072)	0.7302 (0.7191–0.7413)
Calibration, brier score	0.070 (0.067–0.072)	0.065 (0.063–0.067)	0.067 (0.065–0.069)

AUC, area under the curve; CI, confidence interval; SAB, Sepsis, Anion gap, Bicarbonate; SAPSII, simplified acute physiology score II; SOFA, sequential organ failure assessment.